same, namely, the production of a complex organic compound. We have been too much in the habit of supposing that when we could represent the process followed by the chemist by an equation, that this equation represented what occurred in the plant or animal tissue. Physiologists more than chemists have erred in this direction, and many of the statements in our text-books are either superficial or grossly misleading. The chemist attains his end by violent means and with considerable rapidity, whereas, in the silent laboratory of the plant and animal cell, molecular processes are slowly carried on of which we know at present next to nothing. It is strange, for example, that we cannot yet follow all the steps of the process by which, under the action of sun-light, the green colouring matter in a vegetable cell can fix the carbon of the carbonic acid of the air and liberate the oxygen. Nor can we follow satisfactorily the steps of the synthesis by which the carbon is built up into such a substance as starch or sugar. Yet this is a synthesis accomplished every day by every green plant. Such phenomena in all probability are accomplished through the agency of enzymes or ferments, but their real nature is still obscure.

I have said enough to show you the vast importance of chemical investigation in the physiology of the future. Chemistry is but a highly specialised branch of physics. In these days all the new discoveries in physical chemistry, such as the true nature of solution, the facts of dissociation as exemplified by such a common phenomenon as the splitting up of common salt into the ions chlorine and sodium, the charging of each ion during electrolysis, and the laws of osmotic pressure, which no doubt regulate nutrition and the interchanges of blood and lymph, must be taken into account by the physiologist. Such research demands adequate laboratory accommodation and highly trained specialists. I am glad to say our university will soon be in a position to take her share in this new development of physiological science. The splendid laboratories now being built for physiology, public health, and materia medica will be a home for work of this kind, and the endowment of a lectureship in physiological chemistry by the trustees of the late Dr. John Grieve (who left 8000*l.* for the foundation of a lectureship in connection with the medical faculty of the university) will enable us to obtain the services of a trained specialist, who will give his undivided attention to this department of physiology. No subject more than physiology illustrates the truth that all science is one. Physics, chemistry, physiology, and all the others are only different ways of investigating the phenomena of nature. The phenomena of life are, however, the most difficult of all to investigate, and it may safely be asserted that the highest skill in experimental research and the deepest knowledge of chemistry and physics are required for such work. Throughout the scientific world physicochemical researches are now in progress into physiological and bacteriological processes, lectureships and laboratories are springing up here and there, and it is gratifying to be assured that the University of Glasgow will be able to take her share in this work.

CONDENSATION NUCLEI.[1]

A FAMILIAR experiment was first shown illustrating the action of ordinary dust particles as condensation nuclei. From a large globe, which had been allowed to stand for some hours, some of the air was removed by opening communication with an exhausted vessel. Only a very few drops were formed as a result of the expansion. On allowing air to enter the globe through a cotton-wool filter, so that the pressure was brought back to its original value (that of the atmosphere), and allowing the air to expand as before, the drops formed were again very few. The ordinary air of the room was now admitted; an expansion of the air in this case resulted in the production of a thick fog.

When air has been freed from dust by filtering, or by repeatedly forming a cloud by expansion, and allowing it to settle, the vapour which, in the presence of the nuclei, would have separated out in drops, must be in the "supersaturated" condition immediately after the expansion is completed.

[1] Discourse delivered at the Royal Institution on Friday, February 19, by C. T. R. Wilson, F.R.S.

Another method of producing clouds was now shown. Air was allowed to escape through a fine orifice into an atmosphere of steam; the mixed air and steam were then passed through a Liebig's condenser, where the greater part of the steam was condensed, and then into a large glass globe, where the clouds were observed. From this vessel the air was drawn off by a pump which maintained the pressure in the globe and condenser at a considerable number of cms. of mercury below that of the atmosphere. Before reaching the jet the air of the room had to pass through a cotton-wool filter, and then through a long tube containing water; finally it was led through an aluminium tube to the orifice. The latter was about half a mm. wide. The fall of pressure in passing through the orifice was about 15 or 20 cm. In the absence of the filter, the air being admitted directly to the water tube through a tap turned just sufficiently to give the same flow as with the filter, a dense fog poured out from the end of the condenser tube; on closing the tap and letting the air enter through the filter the fog rapidly cleared, and only a fine rain continued to be produced. While the apparatus was in this condition an X-ray tube was set in action near the aluminium tube; the rain was succeeded by fog, which continued to pour out from the end of the condenser so long as the X-rays were kept in action. Condensation nuclei are, as this experiment proves, produced in air exposed to Röntgen rays. Later experiments will, however, show that they have entirely different properties from the ordinary dust nuclei.

When air has been completely freed from dust particles, so that a slight expansion of the air (initially saturated with water vapour) does not result in the formation of any drops, it is found that quite a high degree of supersaturation may be brought about without the appearance of a single drop. There is, however, a limit to the supersaturation which can exist without condensation of the vapour in drops resulting. To study this condensation in dust-free air, and to measure the expansion required to produce the necessary degree of supersaturation, a special form of expansion apparatus is required. The lantern slide thrown on the screen shows the construction and mode of working of the apparatus. The second slide is a photograph of the machine in action, the exposure having been made immediately after an expansion; the cloud formed (in this case on nuclei produced by the action of radium) is plainly visible along the path of a concentrated beam of light from a lantern.

Let us now try an actual experiment with the expansion apparatus. On making a slight expansion a cloud forms on the dust particles which are present; this slowly settles to the bottom of the vessel. The air is allowed to contract to its original volume, and a second expansion of the same amount is made. The drops formed are on this occasion comparatively few, and they fall rapidly; the dust particles have nearly all been carried down with the drops formed by the previous expansion. The fewer the nuclei on which water condenses the larger will be the share of water available for each drop, and the more rapid will be the fall. The next expansion produces no drops. While the air is in the expanded condition, the piston being at the bottom of the expansion cylinder, air is removed from the cloud chamber by opening the connection to the air-pump until the pressure is about 13 or 14 cm. of mercury below that of the atmosphere; the piston is again allowed to rise by putting the air space below it in communication with the atmosphere. The next expansion is thus comparatively large, the pressure after the expansion has taken place and the temperature has risen to its original value being 13 cm. or more below the initial pressure. Yet, in spite of the high degree of supersaturation reached, not a drop of water is seen. Making the fall of pressure 16 cm., however, we see on expansion a shower of drops; and although these drops are few and large, falling therefore rapidly, yet, however often the same expansion be repeated, the drops produced on expansion show no diminution in number. Thus the nuclei removed with the drops are continually replaced by others manufactured within the apparatus itself.

To produce the necessary supersaturation to cause condensation in the form of drops in dust-free air, the air must be allowed to expand suddenly until the final volume is 1·25 times the initial volume. The condensation is rain-like in form, and, moreover, the number of drops remains small although the expansion considerably exceeds this lower limit.

Expansions exceeding the limit, $v_2/v_1=1·38$, however, give fogs, which increase rapidly in density, *i.e.* in the number of the drops, as the expansion is increased beyond this second limit. The expansions required for the rain-like and cloud-like condensations correspond to a fourfold and eightfold supersaturation respectively.

A further experiment will throw light on the nature of the nuclei associated with the rain-like condensation. Let us expose the moist air to the action of X-rays before causing it to expand. First let us try an expansion very slightly less than that required to give the rain-like condensation without the rays. You observe no drops are formed. Now let the expansion be slightly greater than the critical value 1·25. A fog is seen on expansion. Thus the X-rays produce in the air immense numbers of nuclei having the same properties, so far as their power of assisting condensation goes, as the comparatively few nuclei which the rain-like condensation makes visible. Now a gas exposed to X-rays conducts electricity, and the otherwise complicated phenomena of this conduction are all reduced to comparative simplicity by the theory that under the action of the rays equal numbers of freely moving positively and negatively electrified bodies (the ions) are produced from the originally neutral gas. It is at once suggested that the condensation nuclei produced by X-rays are simply these ions.

Let us now impart conducting power to the gas by exposing it to the action of the radiation from radium. Again we have the same result; no drops are produced if the expansion be less than 1·25, fog if the expansion exceeds this limit.

If we substitute for the glass shade, which has thus far formed the cloud-chamber, a glass cylinder with a horizontal metal top, we have the means of testing whether the condensation nuclei produced by Röntgen or radium rays are really electrically charged, whether, in fact, it is the ions themselves which act as condensation nuclei or other particles produced by the rays. If, for example, the roof of the cloud chamber be kept positively charged, the floor negatively, the negatively charged ions will travel upwards and the positively charged ones downwards. In the absence of an electric field the positive and negative ions produced by the action of the rays will go on increasing in number until as many are neutralised by recombination with ions of the opposite kind, or by coming in contact with the walls of the vessel, in each second as are set free in that time by the rays. If the rays be cut off, the removal of ions by recombination and diffusion will continue, and the number of ions in the vessel will diminish rapidly.

Experiment shows that, while in the absence of an electric field, quite a considerable fog is formed when an expansion, slightly exceeding 1·25, is effected ten seconds after the rays have been cut off, with 200 volts between the upper and lower plates the same expansion, allowed to take place three or four seconds after the stopping of the rays, produces only a very slight shower. Or, again, if the rays be kept on all the time the resulting fog is very much less dense with the electric field acting than without it. These results are easily explained if we assume that the condensation nuclei are the ions, and apply the result obtained by purely electrical methods, that the ions travel about 1·6 cm. per second in a field of 1 volt per cm. The nuclei causing the rain-like condensation without exposure to Röntgen or radium rays are also removed by the action of an electric field; we have thus the direct proof that they also are ions. Recent experiments have proved that a charged conductor suspended within a closed space loses its charge by leakage through the air, and that the conduction shows all the peculiarities of that met with in an ionised gas; and, indeed, it appears that this ionisation is due to the action of radiation of the radium type from the walls of the vessel and from outside the vessel. The condensation method of detecting ions is, it may be pointed out, a very delicate one; a single ion if present in the vessel will be detected.

The positive and negative ions are not alike in their power of acting as condensation nuclei. In most of the experiments shown to-night the negative ions alone have in fact come into action. The positive require a considerably greater expansion in order that water may condense upon them. The final volume must for the positive ions be about 1·31 times the initial instead of only 1·25, corresponding to a sixfold instead of a fourfold supersaturation.

To demonstrate the difference between the positive and negative ions the same form of apparatus is used as in the previous experiment. Instead, however, of a difference of potential of 200 volts, only 2 or 3 volts are applied between the plates; and in this experiment only a thin layer close to the lower plate is exposed to the action of the rays. Under these conditions, if the upper plate is the positive one, the negative ions will be attracted upwards out of the ionised layer, and will occupy the greater part of the volume of the vessel, while the positive ones will have only a short distance to travel before reaching the lower plate. If the rays be cut off before the expansion is made it is easy to arrange the interval to be of such a duration that all the positive ions have been removed, while only a small fraction of the negative ions have reached the upper plate before the expansion takes place. Thus we can try the effect of expansion when the vessel is charged with practically negative ions only. By reversing the electrical field the action of positive ions, almost free from negative ions, can be studied. When the expansion is between 1·25 and 1·31 a fog or a mere shower is obtained, according as the direction of the field is such as to drive negative or positive ions upward.

The ions are by no means the only nuclei which can be produced within moist air from which the dust particles have been removed. Among the most interesting of such apparently uncharged nuclei are those produced in moist air exposed to ultra-violet light. It is impossible in the time available to do more than allude to them here.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The reader in animal morphology (Mr. Sedgwick) gives notice that a special course of advanced lectures on certain general aspects of zoology will be given at the zoological laboratory during the Michaelmas and Lent terms, beginning Friday, October 28. The course will include lectures by the following, and will be given as nearly as possible in the order indicated:—Michaelmas term: Mr. Doncaster, the nucleus and heredity; Mr. Lister, Foraminifera and Mycetozoa; Mr. Punnett, metamerism. Lent term: Mr. Gardiner, the œcology of aquatic animals; Mr. Brindley, certain aspects of regeneration; Mr. Hopkins, animal pigments; Mr. Fletcher, cell-structure, cell-division, and maturation of germ-cells; Mr. Heape, some problems connected with the comparative physiology of the generative system.

Dr. Donald MacAlister, St. John's, who has represented the university on the General Medical Council since 1889, and is now chairman of the British Pharmacopœia Committee, was re-elected for a fourth period of five years on October 24.

A university lectureship in applied mathematics is vacant by the appointment of Mr. H. M. Macdonald to be professor of mathematics in the University of Aberdeen. The readership in botany is vacant by the resignation of Mr. Francis Darwin. These offices will be filled up during the present term.

The Gedge prize in physiology has been awarded to Mr. K. Lucas, fellow of Trinity, for his paper on "The Augmentor and Depressor Effect of Tensions on the Activity of Skeletal Muscle."

The number of students of the first year matriculated on October 21 was 884, or for the whole year up to that date 923.

The late Mr. Henry Evans, of Trinity College, bequeathed to the university his collection of British Lepidoptera.

The following examiners have been appointed for the natural sciences tripos:—Physics, R. T. Glazebrook and W. C. D. Whetham; chemistry, H. O. Jones and Prof. A. Smithells; mineralogy, Prof. W. J. Lewis and L. J. Spencer; geology, A. Harker and Dr. F. A. Bather; botany, A. C. Seward and H. Wager; zoology, A. Sedgwick and Prof. W. A. Herdman; physiology, W. M. Fletcher and Prof. E. Waymouth Reid; anatomy, Dr. E. Barclay Smith and Prof. A. Robinson.